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Emergency Department Real Time Location System Patient and Equipment Tracking

PRINCIPAL INVESTIGATOR:
Michael Mutter MS RP CPPS

CONTRACTING ORGANIZATION:
The Valley Hospital
Ridgewood NJ 07450

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Michael Mutter MS RP

email:
mmutter@valleyhealth.com

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Society of The Valley Hospital Inc.223 North Van Dien Avenue

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14. ABSTRACT

The Valley Hospital proposes to continue and expand their current work to implement an Emergency Department (ED) Patient and Mobile Equipment Tracking pilot project in an effort to identify key opportunities to drive operational efficiency, improve patient satisfaction, and increase asset utilization. The project will also focus on researching opportunities to leverage the technology in a military setting in collaboration with the Telemedicine and Advanced Technology Research Center (TATRC). The proposed research project intends to demonstrate the effectiveness of using middleware to homogenize data produced by varied real time location system (RTLS) platforms for consumption by a common user interface and application. The project is intended to lead the way to further study of the application throughout the hospital in the inpatient and peri-operative setting.

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Introduction

The Valley Hospital continues to expand their work on medical error reduction by implementing a Mobile Equipment Tracking system utilizing a real time location system along with radiofrequency tagging. The initial phase of the project built a hospital-wide infrastructure of RTLS hardware and defined the desired zone-based configuration needed for adequate tracking. AgileTrac software was then installed to pass the milestone marks to disparate systems for the purpose of location, preventative maintenance or repair of tagged equipment. The proposed research project intends to demonstrate the effectiveness of using middleware to homogenize data produced by varied real time location system (RTLS) platforms for consumption by a common user interface and application. The project is intended to lead the way to further study of the application throughout the hospital in the inpatient and peri-operative setting tagging other assets as well as patients and caregivers.

Body

Background: The Valley Hospital proposes to implement a real time location system (RTLS) to locate asset management and patient flow in a healthcare setting. This system will be implemented in a phased approach to accommodate the absorption of the technology and integration with existing workflow processes and computerized information systems. This proposal will detail the Hospital's intent to implement a pilot project in the Emergency Department (ED) Patient flow and include Mobile Equipment Tracking in that area to identify key opportunities to drive operational efficiency, improve patient satisfaction, and increase asset utilization. The pilot project will also focus on researching opportunities to leverage the technology in a military setting in collaboration with the Telemedicine and Advanced Technology Research Center (TATRC).

The RTLS industry contains many proprietary, vendor-specific hardware and software platforms which are designed to 1: promote a particular technological development agenda, or 2: overcome a perceived or actual environmental characteristic. This proposed project is not intended or designed to promote or advocate for one technology over another, but to promote a framework where multiple, disparate RTLS technologies can coexist in the same ecology and allow their disparate outputs to be merged into a cohesive, organized flow of information. This research project proposal intends to demonstrate the effectiveness of using middleware to homogenize data produced by varied real time location system (RTLS) platforms for consumption by a common user interface and application.

Subsequent phases of the project will include Patient flow, clinical process management and Mobile Equipment Tracking in the Perioperative Suite, expansion of Mobile Equipment Tracking to include beds, intravenous infusion pumps and other movable assets of critical clinical nature for the entire campus, additional phases will include patient flow and clinical process management to improve critical or time-sensitive events.

Hypothesis: We believe that diverse, disparate, wireless real-time location tracking technologies can co-exist in a single environment and that the positional information they provide can be merged into a single set of data outputs that can provide a single pane-of-glass view of the real-time location of materiel assets, clinical process management and patient flow that these data outputs can also be sent to ancillary asset and workflow systems based on their parochial interests. We further believe that, by enabling this homogenization of information supplied by the most appropriate RTLS systems that are installed, we can improve operational efficiency, improve patient satisfaction, increase asset utilization and positively impact patient safety

Technical Objectives:

- Select and implement a Real-Time Location System (RTLS) in The Valley Hospital Emergency Department. This implementation will provide relevant (room-level or bay-level) positional information for tagged movable assets and during a future phase, patients admitted to the Emergency Department. The system will provide zonal positional information for all other areas of the Hospital Emergency Department.

- Ensure the solution complies with all RF transmission guidelines to avoid interference with Hospital's wireless communication systems and clinical modalities.

- Select and implement an RTLS Server ("middleware") application. The purpose of the RTLS Server will be to homogenize the output from the RTLS System for consumption by heterogeneous computerized information systems. The middleware application must be scalable to allow for inputs from multiple, disparate, RTLS systems as well as multiple, diverse, parochial information systems. The middleware application must be compatible with multiple interface specifications for the heterogeneous computerized information systems. The middleware application must contain user-configurable, rules-based workflow and notification components to guide information delivery and notification processes for key events.

- Interface the RTLS Server to the Hospital's Emergency Department information system. This interface will provide real-time positional data which will be consumed and processed by the information system to display the current location for each admitted patient on the unit in a later phase.

- Interface the RTLS Server to the Hospital's bio-medical device asset management system. This interface will provide real-time positional data which will be consumed and processed by the asset management system to facilitate asset location for any device needing repair.

- Select and implement an RTLS in The Valley Hospital for positional reference of staff and patients throughout the campus. The system will provide zone-based coverage for patient care units and designated areas. The system will provide threshold or other relevant positional information to the RTLS Server for analysis of event-driven triggers in a later phase of the project.

- Select and implement an RTLS in The Valley Hospital for positional reference of materiel assets throughout the campus. The system will provide zone-based coverage for patient care units and designated areas. The system will provide relevant positional information for key areas within the patient care units and other designated areas in a later phase of the project.

- Identify opportunities to leverage the use of the RTLS Server rules to enhance patient throughput initiatives and other operational efficiencies through the improved utilization of materiel assets, coordinated event alerting based on key relevant positional triggers to improve workflow processes in a later phase of the project.

Military Significance: Creating a method for homogenizing location data from disparate RTLS systems that will allow multi-vendor sourcing of hardware and accelerate the adoption of multi-site implementations. Current manual asset management processes often cause insufficient availability of assets, labor-intensive physical inventories, shrinkage and inadequate asset maintenance as well as uncertainties in readiness status, which can impact the critical patient care issues. Real-time asset management systems based on RTLS technology can reduce inventory requirements, ensure adequate inventory to meet operational demands, minimize shrinkage of assets, and improve productivity and accountability. The technology platform being introduced will enable these benefits and provide an open framework on which vendors can create solutions.

The military already has disparate RTLS systems actively deployed. This project would allow for the continued selection and implementation of diverse RTLS technologies that are designed to meet the environmental and process requirements while enabling cross-departmental information sharing and more effective asset mapping for logisticians.

Public Purpose: This project would provide a framework for product evaluation and selection by organizations wishing to invest in RTLS technology but confused by the diverse solutions and lack of standardization. Our project will afford organizations the opportunity to select the most appropriate RTLS technology solution(s) for their environment while allowing for information-sharing requirements to parochial, legacy information systems. Wifi-based RTLS systems could coexist in the same organizational ecology as RF/IR systems based on the department or unit’s needs. The positional information available from each RTLS would be processed by the centralized RTLS Server and integrated through its rules engine to spawn correlated event notification to interested parties and present a holistic view of managed assets.

In addition to the technical application advancement, the ability of the system to generate milestone marks as well as location of patients and assets will be a tremendous assist to gaining healthcare efficiency, increased patient satisfaction and enhanced patient safety.

Healthcare organizations struggle with the ability to track their assets for example, I.V. infusion pumps. The ability to readily locate pumps at the moment they are needed will ensure the patient is receiving their medication therapy in a timely manner, which is an important patient safety issue. The fact that the employee didn't have to spend an excess amount of time to locate the pump is an employee satisfier. The system's ability to track assets will help organizations to purchase the right amount of pumps and create cost savings.

The ability to track patients through their steps in the care process using a real time location system will help healthcare organizations learn what processes can be improved upon to increase efficiency and provide timely, safer care for patients. The milestone marks generated by the RTLS will be far more objective allowing benchmarks to be established so healthcare organizations can use them in their process improvement activities. In so doing, care will be delivered to patients in a way that will minimize risk, minimize bottle-necks in the system and hasten diagnosis and start of treatment to the patient. In addition, creating capacity for staff to spend more time at the patient's bedside.

Collectively, these enhancements will create safe, patient-centered, effective, efficient and timely care. These elements reflect the vision of health care for the American public written in the Institute of Medicine's report, "Crossing the Quality Chasm."

Methods: The testing methodologies to be used will confirm the accuracy of the solution, displaying the asset on an electronic map that consistently corresponds to a real-life physical location. The process for vetting the solution will require repeatable results establishing positive identification that an identified asset's RTLS Server location matches it's real-life, physical location whether it be zone-based or room-based level of granularity. We will perform this testing using a tagged asset. Using the positional reference software map contained in the RTLS Server, observe and compare that that to the physical "real life" location. The testing method will be deemed successful when we can confirm a statistically significant number of occurrences that the tagged asset is displayed within 3 feet of its "real life" location. In zone-based coverage areas, confirm that a statistically significant number of positive occurrences exist to locate the asset in the software match the "real life" location. Further testing will include confirmation that interfaced heterogeneous information systems include the appropriate location values as are observed within the RTLS Server. This location information must be consistent and updated in the heterogeneous information system within 300 milliseconds of a location-change event generated from the RTLS.

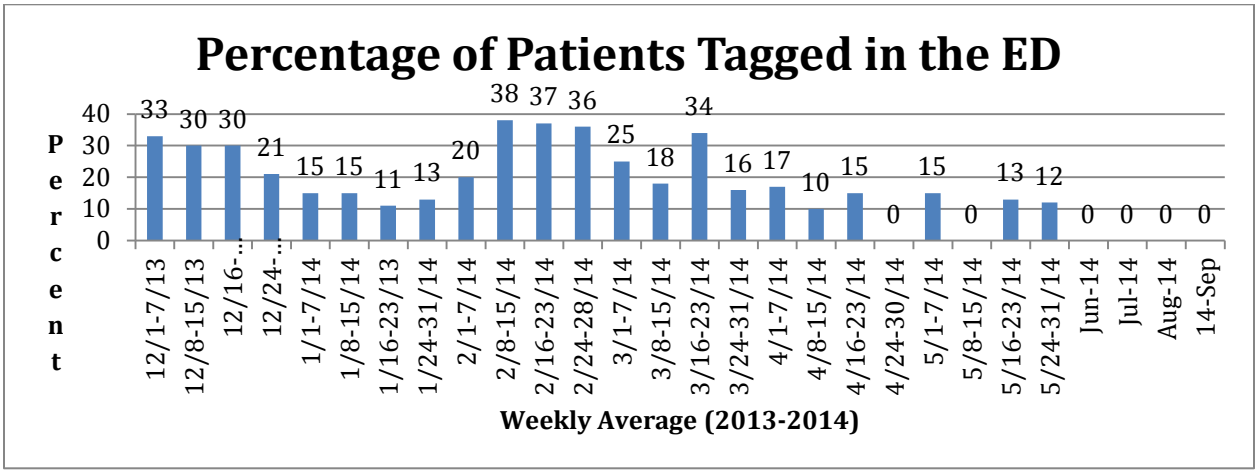
Key Research accomplishments/Reportable Outcomes

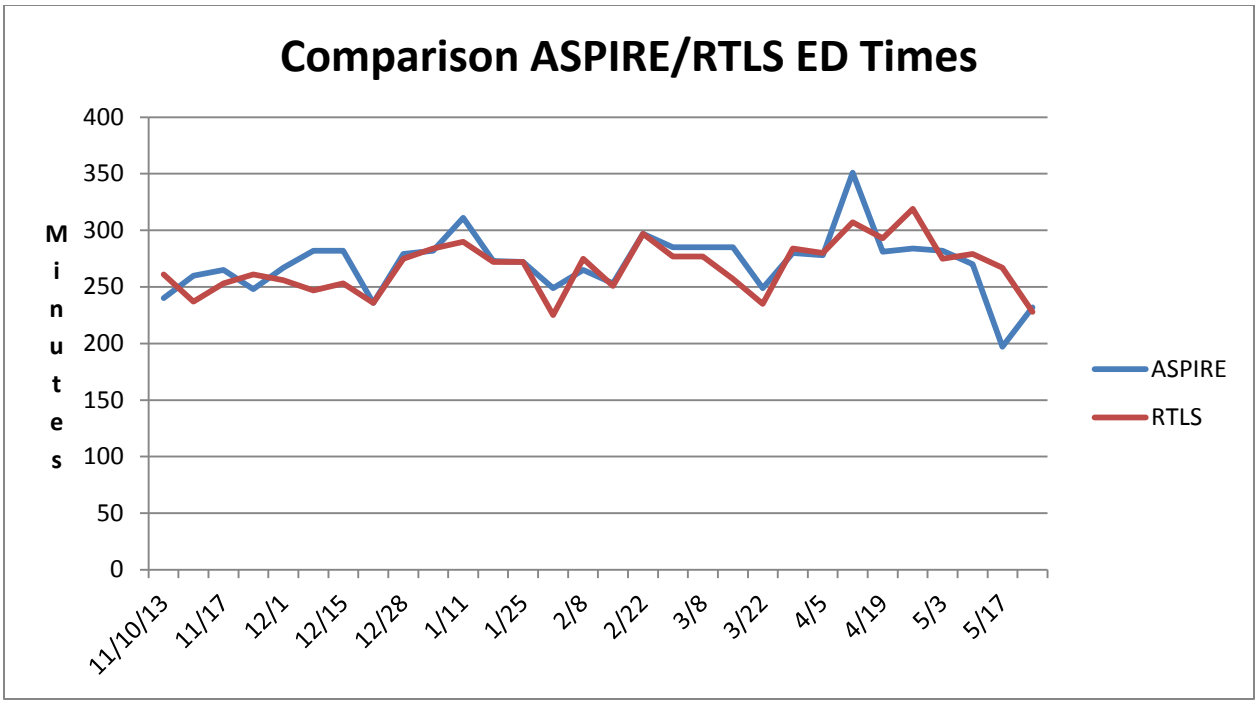
Patient Tagging: Getting staff to embrace the change in their workflow and apply the RFID tag and band as well as getting staff and the patient to be aware of the need to remove the tag/band prior to patient discharge continues to inhibit the success of the project. Obviously, fewer tags available for use, adds stress to the system and less room for slippage and inaccuracy. The timing for processing the used tags becomes time dependent and very tight. If this doesn't work in synchrony, tags will not be available for patient association which means fewer patients get tagged.

The research team has spent a great deal of energy working with the ED staff and leadership on a daily basis to increase compliance with the processes. The real time location of the tagged patients is being identified. This is intended to be the volume load test for the future phase of the project in which all patients from various admission points are tagged. It is not clear whether the ED staff value this information.

The vendor has offered a potential solution by offering a visual alarm/signal tower which would provide a "stoplight" concept of a red light goes on if a patient passes the exit with a RFID tag still on. We have received the device however the vendor is researching how best to utilize the technology to meet the need. The ability to limit the range for reading an RFID tag to prevent false alerts is presently being worked on.

Tag loss mitigation has become the rate limiting step in being able to successfully continue to the patient tagging portion of this project. The graph below shows the percent of patients coming through the Emergency Department (ED) that have been tagged on registration. As tags are lost and inventory diminishes, the ability to clean the tags in designed timeframe is diminished which results in fewer tagged patients. This results in the staff becoming less mindful of the tagging process. The graph depicts the scenario just described.





Early results of comparing timestamps captured via RTLS vs. manual (ASPIRE) timestamps indicate RTLS timestamps are on average 10 % shorter.

The I-dashboards are live and recording results of patient tagging on a daily basis. The essence of the research question posed in this project was to capture defined key movements of the patient through their Emergency department encounter and compare them to the same key movements that are manually captured. The research premise is that RTLS times captured are equal to or shorter than those manually recorded. To date, the results show that average overall arrival to departure of the ED patient to an inpatient unit is 258 minutes which matches to the minute with the manually data capture of 258 minutes.

The average overall time that a treat and release patient spends in the ED through the ASPIRE data collection process is, 164 minutes versus 181 minutes captured via RTLS. The explanation for the difference between the two times is the pediatric patients presented in the ED do not receive an RFID tag. This population of patients has the shortest length of stay in the ED as treat and release patients thus bringing down the overall average.

The addition of 2 minutes recorded for Arrival-Enter Triage is accounted in the ASPIRE data collection process as registration time. The RFID tag is placed on the patient at the end of the registration process. Hence the 4 minutes represents the same measurement.

The metric, Admit to ED IP departure is measured with different timestamps in ASPIRE versus RTLS however the intent is to capture the same segment of movement. In the ASPIRE timestamp the measure begins at registration and ends when the patient status is changed to inpatient in the HIS system. In the RTLS system the capture begins on registration and ends when the patient physically departs the ED by passing the signpost at the department exit.

Comparison of other metrics is showing RTLS times to be shorter than manually entered times for the following timestamps.

Metric	Duration (Min) ASPIRE	Duration (Min) AgileTrac
Arrival - ED Departure	190	181
Arrival - ED Departure Out Patients	164*	181
Arrival - ED Departure In Patients	258	258
Arrival - Enter Triage	6*	4
Enter Triage - Exit Triage	9	9
Arrival-Enter ED Exam Room	20	18
Enter ED Exam Room - ED Departure	190	186
ED Drop Box Departure - Discharge	N/A	15
Arrival - Discharge	196	200
Admit - ED IP Departure	59*	67
Admit - Enter IP Room	99	99
ED IP Departure - Enter IP Room	N/A	32

Asset Tagging Process: RFID tagging and RTLS has made the role of Materials Management Coordinator at The Valley Hospital much more efficient and has allowed the Coordinator to expand his role and add value to the organization. Before equipment was RFID tagged, the Materials Management Coordinator would have to round on all of the in-patient units searching for important clinical equipment. This would take a full 8 hour shift to accomplish and take away from other duties.

With equipment RFID tagged, the Coordinator can ensure that important equipment can be found in seconds, equipment can be utilized instead of being static in unoccupied patient rooms or clean utility rooms, monitor if equipment was cleaned properly by environmental services and insure that yearly maintenance dates are met for all equipment.

This tool will be used to improve other areas, Adult code carts will be tagged to help our central supply and distribution department eliminate supplies from reaching their expiration dates. This will reduce product waste and increase workflow by being able to approach time dependent work with predictability.

Rental equipment will be tagged to track location so it can be returned to the vendors on the date it stops being used. This will add workflow efficiency in tracking the rental equipment as well as cost savings from not having to pay on extra rental days while the equipment is being found.

In a recent mock Joint Commission survey, the finding that came out throughout the organization was clutter in hallways which block egress in case of emergency. Excess equipment increases hazard of trips and falls for patients, visitors and staff.
Lack of storage has been perpetuated over the years as space once designated for storage of equipment has been redesigned into clinical functioning space or office space. At the same time advances in technology have facilitated the purchase of even more equipment.
With the tension mounting as a result of this multifactorial issue a solution is being sought.
The investigator believes that the RFID/RTLS technology can further assist in the successful management of equipment supply and storage logistics.
Before further development of this plan can take place, a process needs to be developed to manage asset tag battery life. At the onset of the RTLS project the Centrax manufacturer projected the battery life of the tags to be 3 years. The investigator's experience is showing an actual life of 1.5 years. With frequent equipment movement as well as numerous access points, the battery is drained much more quickly.
A low battery equipment tag report has been developed and generates a list of tags that fall below a threshold of signals which indicate the battery has limited life. The information is then parsed to either the Biomedical engineers to be address during clinical equipment preventative maintenance process or the Engineering department managing larger transport equipment, beds, stretchers, wheelchairs, etc.
The current phase of the process is locating the equipment that may have a dead tag and get them retagged. Once this is complete, the inventory will all be accounted for.
The RTLS reports that show equipment movement history will be used to identify opportunities to reduce the quantity of inventory of particular pieces of equipment. One of the main goals is to determine the right amount of equipment needed in the organization.
The Valley Hospital's Materials Management Coordinator is working on a project to reduce hospital clutter in response to the mock Joint Commission survey by removing excess equipment from the corridors of the hospital. The Coordinator created an inventory of all equipment using the RTLS system. The use of the equipment is assessed by movement history found in the RTLS system. Excess equipment is then being sent to an off-site location, utilizing the RTLS system by adding a sign post at the location, the inventory can be managed for preventative maintenance and redistribution back to the hospital as needed. The organization is due for its' tri-annual accreditation survey by The Joint Commission in 2014 and clutter has been a finding in the past. During this period of performance 200 pieces of RFID tagged equipment has been moved to the offsite location and ready to be managed by the process described above. There has been a delay by the vendor in getting the remote sign post installed in order to utilize the RTLS system for tracking and locating the equipment when dispatched for use back in the hospital.

The vendor has resolved their inability to provide a regularly scheduled, reliable report of low battery RFID tags. A weekly report is now being provided and is utilized by the Biomedical engineering department to change tags having a low battery when preventative maintenance is being performed on the piece of equipment.

Once this is established a process to transport and offload a percentage of the equipment from the hospital campus to a local storage facility will reduce the clutter. The next step will be to use the RTLS reports to capture the amount of movement and use of each piece of equipment then based on these findings, build a ”just in time” delivery scheduling process to support the equipment needs at the hospital and timely removal of equipment not needed on site.
The RTLS vendor has advised that a sign post can be installed at the warehouse location to assist in managing and accounting for each piece of equipment as well as managing low battery.
The current process for cleaning the equipment is taking place on the patient care units. A number of variations in this process were identified during analysis. Not all equipment could be distinguished as having been cleaned, clean and soiled equipment were interspersed in clean and soiled utility spaces, in hallways as well as, patient rooms.
The original design of the RTLS process established a workflow which could track the movement of equipment through the clean to soiled to clean states. Analysis of the RTLS tracking reports showed an overall compliance rate between 30-50% of equipment traveled through the process as designed. Through observation, the findings validated the reports however, the process as designed didn’t meet the staff workflow. The contributing factors to the hindered success are: the limited space in the soiled utility rooms does not make it conducive for the Service Associate (SA) to clean the equipment there. The nurse needs a piece of equipment quickly and asks an SA to clean it and bring it directly to the patient’s room. Soiled equipment in a patient’s room that is undergoing a terminal clean may have the equipment cleaned in the patient’s room as well. This usually occurs if the nurse tells the SA that a patient is waiting to be admitted into that room.

The investigator offers a hybrid solution to the cleaning and storage of equipment.
The material management process using RTLS established equipment par levels for each unit. As stated earlier, this segment of the project has worked very well. It has proven to be an efficient, effective way to manage the location and movement of equipment to where it needs to be.

Conclusion

This research has demonstrated the ability to capture timestamps of a patient’s movement through an Emergency Room visit using RFID and RTLS. This success is attributed to the ability to accurately recreate the key performance indicators (KPIs) as defined in the ASPIRE workflow into timestamps using RTLS. The output of this design allows for an accurate comparison of the data between the two systems.
The hypothesis that RTLS can provide times equal to, or possibly shorter, than the manual data entry process was proven to be a true statement.

Experience with RFID and RTLS in managing assets has proven to be an effective, efficient and job satisfying technologic advancement. As described earlier in this report, the continued development of its application in order to optimize the number of pieces of equipment to have, the process for cleaning, repair and preventative maintenance and all the logistics of equipment movement will be mapped in the next phase of this project.